International Journal of Food and Agricultural Economics
ISSN 2147-8988, E-ISSN: 2149-3766
Vol. 10, No. 2, 2022, pp. 131-141

DOES HUMAN CAPITAL INFLUENCE AGRICULTURAL PRODUCTION? A CASE STUDY ON CEREALS PRODUCTION IN THE CEMAC ZONE

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Abstract:

The main objective of our study is to analyse the influence of human capital on agricultural cereal production in the CEMAC countries. To achieve this, we use a set data from World Bank (WDI) publications from the period of 2001 to 2017. These data are analysed by the fixed effects model following the ordinary least squares method. The given results show that an increase of one-unit in the total primary school enrolment variable leads to an increase of a 0.672-unit in cereal production. A one-unit increase in public spending on health leads to a 0.048-unit increase in cereal production. This means that human capital positively influences cereal agricultural production in the CEMAC countries. It is commend that producers be trained and supervised on appropriate seed techniques and that an observatory be set up to monitor and evaluate the training and supervision of farmers.
Keywords: *Agricultural production, cereals, education, economic development, health.*
JEL Codes: *Q12, I15, 125,*

1. Introduction

Agriculture is the main sector of economic activity in CEMAC member countries. It produces food and employment but still remains underdeveloped. Overall, more than 50% of the CEMAC population depends on agriculture. Although the situation varies greatly from one country to another, we notice that the agricultural sector employs nearly 65% of the zone's workforce and contributes about 25% of the sub-region's gross domestic product (Avancho, 2013). In 2018, industry contributed at the level of 1.4 percent to the region's real GDP growth. Services have contributed at the level 0.8 percent, while agriculture has represented accounted for 0.3 percent. The part of the agricultural sector has declined a fall and rise up to only 17% of GDP, cash crops accounting the most of production (African Development Bank [AfDB], 2018). Rigorous regional policies have allowed and regional growth from 1.9 in 2019. The economic shock associated with the COVID-19 pandemic has occurred and CEMAC experienced a recession of 3% in 2020 (International Monetary Fund [IMF], 2021).

In most countries of the CEMAC sub-region, there are more noticeable changes in eating habits, mainly in the cities, with a high consumption of imported products, particularly rice and wheat flour products, often resulting in significant foreign exchange outflows. Cereal

production in Central African countries is for great importance to facing food insecurity. In Cameroon, for example, a maize count culture that's levels of production is one of the most noticeable (Tchuenga & Saha, 2017). The debate on the development of agriculture in order to eradicate hunger is not new. The 2008 edition of the World Bank's report on "Agriculture for Development" had a particular resonance. Its publication in October 2007 was just before the "food riots". This highlighted the importance and urgency of food issues. This report reflects a shift in the way this institution and many actors and economists view the importance of agricultural development in strategies and policies to fight against hunger (World Bank, 2007).

Recognising the importance of the agricultural sector, States members have adopted common agricultural policies with particular attention to the role of human capital, especially in rural areas. CEMAC's common agricultural strategy is therefore a part of a broad process of common economic policy whose role is to "promote the constitution of a community market of state member, in particular by coordinating sectoral policies and harmonising existing regulations in order to achieve a progressive economic integration of the region's economies" (Avancho, 2013). According to the AfDB (2018), increased commodity exports and agricultural production supported public investment in infrastructure, contributing to improved the economic growth in 2018. The economic development of African countries is therefore based on agriculture. It mobilises an impressive workforce and generates a lot of income to farmers. But agricultural practice still remains traditional and is not adapting quickly to modernisation to respond effectively on needs which increase more and more in terms of food and development. This situation is the result of illiteracy among production actors. This illiteracy (lack of training, guidance, supervision, and poor health management) has affected agricultural production year after year.

The transformation of economies through regional integration is also achieved through the development of human capital. Quality human capital is defined as the development of innovation capacities and technology transfers. "The redistribution of skilled human capital across different parts of the economy promotes an inclusive development, increased value addition, a greater diversification, increased productivity and industrialisation" (AfDB, 2018).

The education sector in the CEMAC sub-region evolves in a general context of growing demography marked by the youth of the population. The need of education is thus increased even though the human, material and equipment resources which are available remain insufficient despite the efforts of each country to create new schools and assign teachers. However, the education system in most CEMAC countries faces many challenges that limit access to education for all children, especially those from poor families, living in rural areas and in zone affected by humanitarian crises.

With regard to the health system in CEMAC countries, the lowest under-five mortality rates in the region are recorded by Congo and Gabon. On the other hand, the highest rates are recorded by the Central African Republic and Chad. As far as life expectancy at birth and the maternal mortality rate concern, there is a strong correlation between the two indicators in CEMAC countries. Indeed, the trend is that as a CEMAC country records a very low maternal mortality rate, life expectancy at birth becomes higher and higher. The human capital challenge is a central issue for all countries. Rich developed countries that know the importance of human capital are investing in many forms in these domains to remain successful and competitive in the global economy (World Bank, 2018). To face the challenges of economic development, the governments of the CEMAC countries have unite themselves, among other many objectives, to regain control of the agricultural sector by adopting common agricultural policies. This vision of the countries of the sub-region, which is to put farmers back to work by working for their satisfaction, is supported by the education and health systems.

It has to be said that despite decades of efforts and great speeches, notably the establishment of common agricultural strategies based on access to training and health in rural

areas, new techniques, support services, the development of agricultural training infrastructures and the development of agricultural transport, the agricultural production systems of CEMAC still remain traditional with low yields, which explains the constant existence of food insecurity.

This situation of traditional agriculture is not only due to the natural constraints (climate change, poor distribution of rainfall, numerous attacks by crop pests, epizootic diseases, declines in soil fertility, etc.) but also to the technical and socio-economic constraints (essentially extensive production systems, low level of equipment and rational use of agricultural inputs, illiteracy, HIV infection, low human resource capacity, low level of professional structuring of producers, etc.). All of the above raises the question of the relevance and effectiveness of health and education on cereal agricultural production in the CEMAC zone. The objective of this study is to analyse the effect of human capital on agricultural cereal production in the CEMAC zone.

2. Literature Review

According to the approach of Becker (1962, 1964) and Mincer (1974), education is seen as an investment decision. For them, education is an investment since it will provide wage gains. For Becker, human capital is a set of productive talents and skills of the worker, whether formal (through education or training) or informal (through experience). Education has a positive effect on the individual. It increases the individual's stock of human capital and his or her productive abilities, and consequently his or her income. the contributions of Denison (1962), Becker (1962) and Mincer (1974) mention that expenditure related to education, vocational training and health care contribute to improving the quality of the workforce and increasing its productivity.

Many empirical studies have been focused on the relationship between education, efficiency and productivity in the agricultural sector. A literature review supported by the World Bank has credited the idea that education has a strong effect on the productive efficiency of farmers. In a meta-analysis of developing countries in Asia and Latin America, Lockheed, Jamison & Lau (1980) show that, on average, farmers with four years of primary schooling have 7.4 per cent higher productivity than their counterparts without primary schooling.

The study of Dietrich et al. (2010) reveals that intensification of agricultural land use is a factor in human-induced yield increases. According to this study, human capital development would improve the efficiency of ordinary factor inputs used, leading to a growth in agricultural output per lot of land. Djomo & Sikod (2012), by using the stochastic production function model, measure the effect of human capital on agricultural productivity and farmers' income in Cameroon. An additional year of education and experience significantly increases agricultural productivity.

Khadimallah & Akrout (2017), attempt to determine how best way to maximise agriculture's contribution to Africa's overall growth and modernisation. Using a sample of African middle-income countries, they study the effect of industrialisation, human capital, economic openness and institutional quality on the value added created by the agricultural sector. Their study found that there is a positive correlation between human capital and the value added created by the agricultural sector. However, Gurgand (1993) finds that education has no or negative returns in agriculture in Ivory Coast. He also shows that the more we have school-going members in a family, the more we have a lower output. In the same sense of idea, Mirotchie (1994) analysing Ethiopian data and reveals that primary education increases productivity while secondary education has no significant effects.

According to Schultz (1961), the field of investigation in human capital can be reduced to five categories, of which investment in health constitutes the first category that refers in particular to all health services and infrastructures as well as to all expenditures that affect the

life expectancy of an individual. Schultz notes that however, investment in health makes the worker stronger, more enduring, less absent, etc. He gives the example of food: increasing the food of a hungry population increases its productive capacity. He gives the example of food: increasing the diet of a hungry population increases its productive capacity.

This opinion is supported by Ribouh (1978), who confirmed that investment in health is also a form of investment in human capital. Indeed, each individual has an initial stock of health that depreciates with age and is increased by investments that can take different forms, including medical care, hygiene, physical exercise, etc. These investments improve the productivity of workers, but also require costs.

A study lead by Piot, Greener & Russell (2007) investigated the influence of economic developments and the cyclical effect of low human capital growth on the productivity of the African economy. The study found that the health effect was an immediate negative influence on production. Their study showed that multiple health indicators are prevalent among developing countries and that poor health doesn't care about engagement in activities. According to Fan & Saurkar (2006), public spending on health contributes enormously to agricultural growth in all regions. Coelli & Rao (2005) in their study found that household health, energy consumption have a significant positive impact on output growth, indicating their ability to achieve total factor productivity similar to technological progress.

3. Methodology

3.1 The Model

Various economic models show the relationship between output levels, stocks of capital, labour-time and the total factor productivity. According to Coelli & Rao (2005), growth of TFP measures the contribution of technical advancement, knowledge and the general development of human capital to the economic growth. Therefore, the presence of this factor in an economic equation is to estimate the effectiveness and efficiency of factors of production and the production process respectively. One of the neoclassical growth models according to Romer (1986) is the Solow-Swan growth model.

We use Solow Growth Accounting Model to decompose agricultural output growth into growth due to capital stock, input of labour and total factor productivity. The product function upon which the results and discussion of this study are based is approximated by the generalized Cobb-Douglas form, formally the Cobb-Douglas function is a special case of a translog function (Greene 2008). Growth (output) is a function of standard input-factors K and L.

$Y_t = F(K_t, L_t)$

Thus the general specification of our model is as follows:

$$PRC = f\{Education, Health, Population, Land\} \quad (1)$$

$$LogPRCit = \beta_0 + \beta_1 logTIEPit + \beta_2 logDPSit + \beta_3 logPRUit + \beta_4 logPOTit + \beta_5 logEDAit + \beta_6 logTARit + \varepsilon_i \quad (2)$$

With, (PRC) Cereal Production, (DPS) Public Health Expenditure, (TIEP) Total Primary School Enrolment, (PRU) Rural Population, (POT) Total Population, (EDA) Employment in Agriculture, (TAR): Arable Land ε_i is the error term and β_i is the vector of associated parameters.

2.1.1 Choice of Variables and Data Source

The dependent variable is the total cereal production in volume of the agricultural sector.

In this study we split human capital into education and health, which in turn will be measured respectively by total primary school enrolment and public expenditure on health:

- *Total Primary School Enrolment*: is the total number of children enrolled in primary education. It is an adjusted net primary enrolment rate. Indeed, education is an important element in improving the productivity of the labour factor. It will be taken into account here by the share of the population with primary education.
- *Public Health Expenditure*: is the total expenditure by governments to improve the health system of a nation.
- *Rural population* (PRU): refers to people living in rural areas. It is calculated as the difference between the total population and the urban population.
- *Total population* (TP): This is the whole population of a country.
- *Employment in Agriculture* (EIA): refers to labour in the agricultural sector. For simplification purposes, we will consider the rural working population as the labour force in the agricultural sector. It is given in millions of workers.
- *Arable Land* (TAR): Arable land is defined as land that can be ploughed or cultivated.

The data used come from a set of World Bank publications (WDI, 2018) and cover the period 2001-2017.

2.1.2 The Tests

2.1.2.1 Test of the Stationarity of the Study Variables

We use the Augmented Dickey-Fuller (ADF) test. This test consists of testing the null hypothesis "we are in the presence of a unit root or non-stationarity" against the alternative hypothesis "we are in the presence of a stationary process".

Examining the stationarity of the different variables in the models by means of the ADF test, the results which are given in Table 1, give us a clearer picture of the behaviour of the variables.

The values in Table 1 represent the augmented Dickey-Fuller statistics. I (0) represents the order of integration of the test in level, I (1) represents the order of integration of the test in difference 01, I (2) represents the order of integration of the test in difference 02. Thus, variables such as cereal production, total population, rural population, public health expenditure, arable land and employment in agriculture are integrated in (in term of) level so they are stationary, which indicates that the means and covariances of these variables are not depend on time. Only the total primary school enrolment variable is stationary at the order of integration of the difference 2 test, which means that this variable is time depend as it is stationary after moving to a second differentiation.

Table 1. Results of the Stationarity of Variables

Variables	Statistics (Prob)	Order Of Integration
Cereal Production	-8,6040*** (0,0000)	I(0)
Rural Population	-16,6148*** (0,0000)	I(0)
Total Population	-17,0816*** (0,0000)	I(0)
Public Health Expenditure	-2,1143** (0,0172)	I(0)
Total Primary School Enrolment	-1,8413** (0,0327)	I(2)
Arable Land	-2,1606** (0,0154)	I(0)
Employment in Agriculture	-1,7243 ** (0,0423)	I(0)

Source: WDI (2018), Authors.

2.1.2.2 Correlation Test

The correlation test is used to analyse the dependence between two variables. Table 2 presents the result of the correlation test of the variables used in the model. We find that the variable to be explained, which is cereal production, is positively correlated with the explanatory variables, which are rural population, total primary school enrolment, public health expenditure, employment in agriculture and arable land. This explains why a change in the variables rural population, total population, total primary school enrolment, employment in agriculture and arable land will lead to a change in the same way in cereal production. But the cereal production variable is negatively correlated with the total population variable because the coefficient assigned to this variable is negative, which means that a variation in the total population will lead to a variation in cereal production in the opposite direction.

Table 2. Results of the Correlation Matrix of the Explanatory Variables of the Model

	LogPRC	**LogTIEP**	**logDPS**	**logPOT**	**LogPRU**	**logEDA**	**logTAR**
logPRC	1.0000						
logTIEP	0,4909	1.0000					
logDPS	0,9094	0,6292	1.0000				
logPOT	-0,4317	-0,2286	-0,4475	1.0000			
logPRU	0,9658	0,4719	0,8872	-0,2398	1.0000		
logEDA	0,6940	0,3575	0,7754	-0,8104	0,5407	1.0000	
logTAR	0,2682	0,2960	0,2846	-0,5014	0,3978	-0,1173	1.0000

Source: WDI (2018), Authors.

2.1.2.3 Hausman Test

The Hausman (1978) specification test is a general test that can be applied to many specification problems in econometrics. But its most widespread application is in specification tests of individual effects in panels. It is used to discriminate between fixed and random effects. This test thus allows us to choose between the fixed effects model and the random effects model.

Table 3. Hausman Test Results

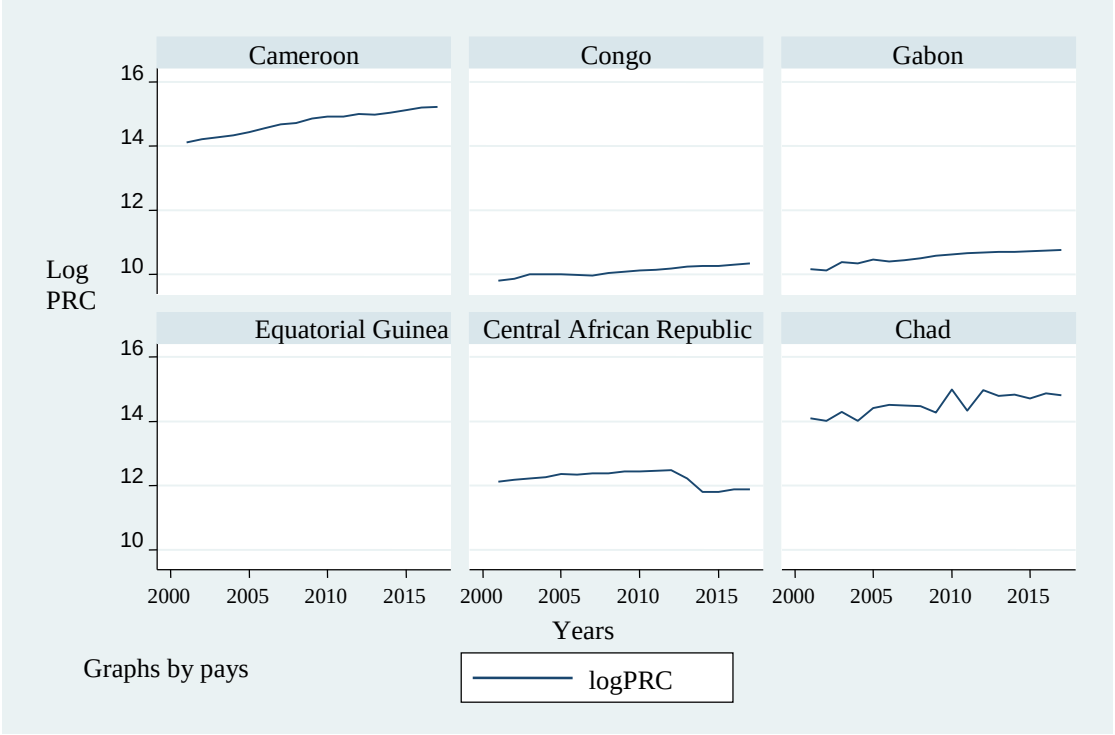
Variables	**Coefficients**		**Difference (b – B)**
	Fixed effects (b)	**Random effect (B)**	
Total Primary School Enrolment	0,6721916	0,1805544	0,4916373
Public Health Expenditure	0,0482807	-0,2343446	0,2826235
Rural Population	0,1902107	1,351627	-1,161417
Total Population	0,6402174	-0.3696865	1,009904
Employment in Agriculture	0,235725	1,53083	-1,294358
Arable Land	-0,008032	-0,1461079	0,138076

Source: WDI (2018), Authors.

Table 3 shows the result of the Hausman test. Our results show that the probability of the Hausman specification test is below the 1% threshold ($p = 0.0000 < 0.001$). Given that, according to the Hausman test, when the probability is lower than the threshold, the fixed effects model is preferred, we can say that the fixed effects model following the ordinary least squares method (OLS) is adapted to our study data.

2.2 The Estimation Method

Regarding the estimation method, inspired by the work of Tchouassi (2018) and based on the Hausman test, we will use the ordinary least squares (OLS) fixed effects model. The fixed effect method provides a solution to the problem of the omission of some important variables, which leads to a biased estimate of the effect of other variables. The important role of the fixed effect lies in the ability to attract and control all unobserved and time-stable characteristics in the modeling without having to measure them. This eliminates much of the bias in the estimation. This is a within subject estimation method. It does not estimate coefficients for variables that do not vary within subject (i.e. variables that do not change over time), such as gender or place of birth. All these variables are controlled by the fixed effects regression even though they are not measured. The use of the non-linear fixed effects model of panel data is problematic in practice because of the problem of incidental parameters and the difficulty of estimating the model with probably a large number of parameters, even with the use of recent technology (Greene, 2008).



Source: WDI (2018), Authors

Figure 1. Evolution of Cereal Production in the CEMAC Zone

3. The Results

3.1 Cereal Production Trends in the CEMAC Zone

Figure 1 shows the evolution of cereal production in each CEMAC country. We see that cereal production varies from one country to another. Cereal production is very high and increasing but not significantly from 2005 to 2015 in Cameroon, and it is also high and fluctuating from 2000 to 2015 in Chad, which can be explained by the fact that more than half

of the populations in these countries live in rural areas and they are mainly engaged in agriculture. The results for Chad and Cameroon corroborate with those of Tchuenga & Saha (2017) who studied cereals, particularly maize, in 2017. However, for these authors, cereal production in Cameroon was 27% lower than in Chad. This situation was caused by climatic variability and biological threats.

Cereal production is insufficient and stagnant in the Central African Republic and very low and stagnant in Congo, which could be explained by the repeated political instabilities in CAR and oil exploitation in Congo. It is low and stagnant in Gabon and even negative in Equatorial Guinea during the period 2000-2015. This could be explained by the fact that both countries are highly urbanised. We can therefore say that the efforts made by Chad and Cameroon have more or less born fruits, but for the whole region we can say that the result is not satisfactory. More effort is needed to face poverty and food insecurity.

3.2 Estimation Results

We thus obtain an adjusted coefficient of determination of the order of 0.5892. This means that 58.92% of cereal production is explained by the exogenous variables of the model. The results also show that the model is globally significant with regard to the Fisher statistic.

Total enrolment in primary school appears with the expected sign. This variable is also significant at the 1% level. An increase of one unit in total primary school enrolment leads to an increase of 0.6721 units in Cereal Production (CRP). Our analyses show that primary school enrolment has a significant and positive influence on cereal production in the CEMAC zone. This can be explained by the fact that the more knowledges producers acquire, the better they will be able to master seed techniques, particularly the use of chemicals and agricultural machinery, which will lead to better crop yields. These results corroborate with those of Lockheed et al (1980), who conducted a meta-analysis of developing countries in Asia and Latin America and showed that, on average, farmers who had attended four years of primary school had 7.4 per cent higher productivity than their counterparts who had not attended primary school.

Table 4. Estimation Results Obtained by the Fixed Effects Method

Explanatory variables	Coefficients	Standard deviation
Constant	6,813026***	1,040682
Total Primary School Enrolment	0,6721916***	0,115352
Public Health Expenditure	0,0482807	(0,0366152
Total Population	0,6402174*	0,3275591
Rural Population	0,1902107*	0,1017131
Employment in Agriculture	0,235725*	0,1362463
Arable Land	-0,008032***	0,0622742
R^2	0,6577	
Adjusted R^2	0,5892	
F-statistic	56,93	
Prob (F-statistic)	0,0000	

Source: WDI (2018), Authors.
Note: *** represents significance at the 1% threshold, ** represents significance at the 5% threshold, * represents significance at the 10% threshold.

Public expenditure on health appears with the economically expected sign. However, an increase of one unit in public health expenditure leads, to an increase of 0.0482 units in cereal production. Our analysis shows that good health has a positive and significant effect on cereal

production in the CEMAC zone. This could be explained by the fact that the CEMAC states have become aware of and invested in the health sector to boost agricultural production, as most countries in the CEMAC zone have agriculture as their main source of income. Farm production is therefore linked to health status in the sense that poor health can affect production if family compensation is inadequate. These results corroborate those of Audibert & Etard (1999), who evaluated the economic benefits of investment in health in Mali.

The coefficient associated with the rural population variable has a positive sign and economically this variable is significant at the 10% threshold. Thus, an increase of one unit in the rural population leads to an increase of 0.1902 units in cereal production. The rural population is a determining factor in production; that is why the states discourage the rural exodus through awareness-raising. As for the total population, an increase of one unit leads to an increase of 0.6402 units in cereal production. This may be due to the fact that the whole population of CEMAC as a whole has become well aware of the importance of agriculture while following the agricultural economic policies adopted by governments.

The variable employment in agriculture has the economically expected sign. Thus an increase of one unit in employment in agriculture leads to an increase of 0.2357 units in cereal production. This could be due to the fact that producers have become aware of the economic importance of agriculture and continue to train in the techniques.

5. Conclusion and Recommendations

In this study, we aimed to evaluate the influence of human capital on agricultural cereal production in the CEMAC zone. Our work shows that human capital has a positive influence on agricultural cereal production according to the fixed-effects method, which is the method chosen according to the Hausman specification test. Thus, an increase of one unit in the level of education leads, all other things being equal, to an increase of 0.6721 in cereal agricultural production, which is captured here by cereal production. An increase of one unit in public spending on health, which measures health here, leads, all other things being equal, to an increase of 0.0482 in cereal production, the variable used to measure cereal agricultural production in CEMAC. We can say from this study that the common agricultural strategy of the countries of the CEMAC zone would be incomplete if it did not study the role of human capital, which deserves an important place in relation to other basic resources.

In view of the role that human capital plays in the agricultural production process, we propose the following economic policy recommendations to CEMAC member countries: lead heavy emphasise to the importance of education in rural areas, not only by building schools but also by making farmers aware of the importance of schooling; provide well-trained teachers and health workers in rural areas; increase the number of health facilities, especially in rural areas; improve access to health care, especially the availability of medicines; set up a monitoring and evaluation programme that will inspect teachers and health care staff assigned to rural areas; train and supervise producers on appropriate seed techniques; set up an observatory to monitor and evaluate training and supervision of farmers. This observatory will be competent to decide on the allocation of the budget allocated to agricultural training and supervision.

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